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CERTIFICATE

I, Kenji FUJIMOTO, a member of Sohshin International Patent Office of Miyaki Bldg., 4-2, Yanagibashi 2-chome, Taito-ku, Tokyo, Japan hereby certify that to the best of my knowledge and belief the following is a true translation into English of the accompanying Japanese Patent Application Serial No. 2001-177682 as well as of the certificate attached thereto.

Signed this 8th day of April 2002

Kenji Fujimoto

Kenji FUJIMOTO

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[Inventor]

[Domicile or Residence] c/o SONY CORPORATION, 7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

[Name] Takao MORI

[Inventor]

[Domicile or Residence] c/o SONY CORPORATION, 7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

[Name] Masaru YAMAGUCHI

[Inventor]

[Domicile or Residence] c/o SONY CORPORATION, 7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

[Name] Isao KAMIYAMA

[Applicant]

[Identification No.] 000002185

[Name] SONY CORPORATION

[Attorney]

[Identification No.] 100094053

[Patent Attorney]

[Name] Takahisa SATOH

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[TITLE OF THE INVENTION] Apparatus and method for forming films

[CLAIMS]

[Claim 1]

A method of forming an organic layer in an organic electroluminescence display which has a substrate, a first electrode layer formed on said substrate with a predetermined pattern, an organic layer comprised of a plurality of organic material layers stacked on said first electrode layer with a predetermined pattern, and a second electrode layer formed on said organic layer, comprising:

aligning a mask having openings corresponding to said predetermined pattern with the substrate on which said first electrode layer is formed;

detachably attaching said mask and said substrate;

sequentially forming a plurality of said organic material layers on said substrate attached with said mask in a plurality of vacuum processing chambers; and

transferring said mask and said substrate between said vacuum processing chambers in an attached state.

[Claim 2]

A method of forming an organic layer as set

forth in claim 1, further comprising forming each of said organic material layers in a different vacuum processing chamber.

[Claim 3]

A method of forming an organic layer as set forth in claim 2, further comprising placing vapor deposition sources for supplying organic materials for forming said organic material layers to said vacuum processing chambers into states capable of supplying organic materials at predetermined evaporation rates when said substrate and said mask are loaded into said vacuum processing chambers.

[Claim 4]

A method of forming an organic layer as set forth in claim 1, further comprising transferring said mask and said substrate through a vacuum transfer chamber connecting said vacuum processing chambers.

[Claim 5]

A method of forming an organic layer as set forth in claim 1, further comprising attaching said mask and said substrate by using a mask formed of a magnetic material and a magnet.

[Claim 6]

A method of forming an organic layer as set forth in claim 5, further comprising sandwiching said

substrate between said mask and a plate-shaped magnet provided with a contact surface fully contacting with a non-film formation surface side of said substrate and attaching said mask and said substrate with a magnetic force of said magnet.

[Claim 7]

A method of forming an organic layer as set forth in claim 1, further comprising separating said mask and said substrate after forming said organic layers and forming said second electrode layer so as to cover said organic layer.

[Claim 8]

A method of forming an organic layer as set forth in claim 7, further comprising attaching and separating said mask and said substrate and a transferring said attached mask and substrate in a vacuum atmosphere.

[Claim 9]

A method of forming an organic layer as set forth in claim 1, wherein said organic layer comprises at least first and second organic layers regularly arranged with different colors of light emitted, and said step of forming a plurality of organic material layers comprises a step of forming said first organic layer by attaching a mask commonly usable for forming said first and second organic layers with said substrate and a step of forming

said second organic layer by separating said mask and said substrate, changing an alignment between them, and attaching them again after forming said first organic layer.

[Claim 10]

A method of forming an organic layer as set forth in claim 9, wherein said organic electroluminescence display comprises first, second and third organic layers regularly arranged on said substrate with different colors of light emitted and said step of forming a plurality of organic material layers comprises

a step of forming said first organic layer by attaching a mask commonly usable for forming said first and second organic layers with said substrate,

a step of forming said second organic layer by separating said mask and said substrate, changing an alignment between them, and attaching them again after forming said first organic layer,

a step of forming said third organic layer by separating said mask and said substrate, changing an alignment between them, and attaching them again after forming said second organic layers and

a step of forming said second electrode layer so as to cover said third organic layers in a vacuum processing chamber.

[Claim 11]

An apparatus for forming an organic layer in an organic electroluminescence display which has a substrate, a first electrode layer formed on said substrate with a predetermined pattern, an organic layer comprised of a plurality of organic material layers stacked on said first electrode layer with a predetermined pattern and a second electrode layer formed on said organic layer, comprising:

an alignment mechanism for aligning a mask having openings corresponding to said predetermined pattern to the substrate on which said first electrode layer is formed and detachably attaching said mask and said substrate;

a plurality of vacuum processing chambers for sequentially forming a plurality of said organic material layers on said substrate attached with said mask; and

a transferring means for transferring said attached mask and substrate to one of said plurality of vacuum processing chambers to sequentially transfer it among the plurality of the vacuum processing chambers.

[Claim 12]

An apparatus for manufacturing an organic electroluminescence display as set forth in claim 11, wherein each of said plurality of vacuum processing chamber forms only one of a plurality of said organic material layers.

[Claim 13]

An apparatus for forming an organic layer in an organic electroluminescence display as set forth in claim 11, wherein each of a plurality of said vacuum processing chambers is provided with a vapor deposition source supplying an organic material for forming an organic material layer.

[Claim 14]

An apparatus for forming an organic layer in an organic electroluminescence display as set forth in claim 11, wherein

said apparatus further comprises a vacuum transfer chamber connecting said vacuum chambers and

said transferring means is arranged in said vacuum transfer chamber.

[Claim 15]

An apparatus for forming an organic layer in an organic electroluminescence display as set forth in claim 11, further comprising an attachment jig for attaching said substrate and said mask.

[Claim 16]

An apparatus for forming an organic layer in an organic electroluminescence display as set forth in claim 16, wherein

said mask is formed of a magnetic material, and

said attachment jig is provided with a contact surface fully contacting a non-film formation surface side of said substrate, has at least the contact surface formed of a plate-shaped magnet, and has the substrate sandwiched between said mask and said contact surface attached with said mask by a magnetic force of said magnet.

[Claim 17]

An apparatus for forming an organic layer in an organic electroluminescence display as set forth in claim 11, wherein said organic layer comprises at least first and second organic layers regularly arranged on said substrate with different colors of light emitted,

said apparatus comprising:

a first alignment mechanism for aligning a mask commonly usable for forming said first and second organic layers with said substrate on which said first electrode layer is formed and detachably attaching said mask and said substrate;

a plurality of first vacuum processing chambers for sequentially forming said organic layers on said substrate attached with said mask;

a second alignment mechanism for separating said substrate on which said first organic layer is formed and said mask, changing the alignment between them to a position to form said second organic layer, and detachably

attaching them again; and

a plurality of second vacuum processing chambers for sequentially forming said second organic layer on said substrate attached with said mask again.

[Claim 18]

An apparatus for forming an organic layer in an organic electroluminescence display as set forth in claim 17, further comprising

a separating mechanism for separating said mask and said substrate after forming said second organic layer,

a vacuum chamber for forming said second electrode layer on said substrate separated from said mask so as to cover said first and second organic layers.

[Claim 19]

An apparatus for forming an organic layer in an organic electroluminescence display as set forth in claim 18, wherein said first and second alignment mechanisms comprise

a mask support member able to support said mask,

a substrate support member able to support said substrate,

an attachment jig support member able to support said attachment jig, and

a movement mechanism for changing the relative positions between said support members, wherein

said mask and said substrate are aligned and the said mask and substrate are attached and/or separated by said attachment jig by changing the relative positions of said support members.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to an apparatus and method suitable for forming an organic layer in an organic electroluminescence display using an organic electroluminescence element (below described as an organic EL (electroluminescence) element).

[0002]

[Prior Art]

An organic EL element is structured by an organic layer comprised of an organic material sandwiched between electrodes comprised of an anode and a cathode. It is known that when voltage is applied across these electrodes, electrons and holes are injected from the cathode and anode into the organic layer of the organic EL element. These electrons and holes recombine to emit light.

In such an organic EL element, a luminescence of for example several hundreds to several tens of thousands of cd/m^2 is obtained with a driving voltage of less than 10V. Further, the organic EL element can emit light having a

suitable color by suitable selection of the luminous material, that is, the fluorescent material. Due to this, a display using organic EL elements is regarded as promising as a multi-colored or full-colored display to take the place of a cathode ray tube (CRT) display.

[0003]

[Problem to be Solved by the Invention]

As the above described organic layer, an organic layer comprised of three to five stacked organic material layers such as a hole injection layer, a hole transfer layer, a light emitting layer, and an electric charge injection layer is known. Each of the organic material layers is formed by vapor deposition of the organic material in a processing chamber.

Each organic material layer may be vapor deposited in same processing chamber. Specifically, this consists of aligning a mask arranged in a processing chamber and having openings corresponding to the pixels of a display with a substrate loaded into the processing chamber, inserting different vapor deposition materials in a plurality of heating vessels arranged in the processing chamber corresponding to the organic material layers, and heating these to cause the evaporation of the materials.

[0004]

However, if forming an organic layer comprised of a

plurality of organic material layers in the same processing chamber as described above, there are the disadvantages that a cycle time of the process for forming the organic layer becomes extremely longer and mass production of a display using organic electroluminescence elements is difficult.

That is, when forming an organic layer comprised of a plurality of organic material layers in the same processing chamber, it is necessary to heat each vapor deposition material for each vapor deposition, a relatively long time is needed until reaching the desired temperature, and a relatively long time is needed until an evaporation rate of a vapor deposition source becomes stable. Due to this, a waiting time before starting vapor deposition for each organic material layer becomes longer. As a result, it takes an extremely long time to form an organic layer.

On the other side, by heating the vapor deposition materials to a predetermined temperature at all times to stabilize the evaporation rate, it becomes possible to shorten the waiting time before starting the vapor deposition for each organic material layer. However, while vapor depositing an organic material layer corresponding to one vapor deposition source, vapor deposition materials also evaporated from other vapor deposition sources, so wastefull consumption of materials cannot be avoided. The

organic materials used for an organic electroluminescence element are very costly, so the production cost of the organic layer swells and, as a result, the mass production of a display using organic electroluminescence elements becomes difficult.

[0005]

A technique for eliminating the disadvantages caused by forming an organic layer in the same processing chamber is disclosed for example in Japanese Unexamined Patent Publication (Kokai) No. 8-111285.

The above publication discloses a technique of arranging processing chambers for vapor deposition of the different organic material layers around a vacuum chamber and transferring a substrate between the processing chambers through the vacuum chamber.

By dispersing the vapor deposition of the organic material layers to different processing chambers, it becomes possible to greatly shorten the waiting time for heating the vapor deposition sources and stabilizing the evaporation rate.

However, if dispersing the vapor deposition of the organic material layers to different processing chambers, alignment work between the substrate and mask becomes necessary in each processing chamber. Due to this, it is impossible to sufficiently shorten the cycle time of the

process for forming an organic layer. Further, during the alignment work, the vapor deposition materials are wasted.

[0006]

The present invention is made in consideration of the above described problem, of which the purpose is to provide an apparatus and method for forming an organic layer capable of shortening a cycle time of the forming process of the organic layer of the organic EL display and suppressing the wasteful consumption of the organic materials used for forming the organic layer.

[0007]

[Means for Solving the Problem]

An object of the present invention is to provide a method of forming an organic layer in an organic electroluminescence display which has a substrate, a first electrode layer formed on the substrate with a predetermined pattern, an organic layer comprised of a plurality of organic material layers stacked on the first electrode layer with a predetermined pattern, and a second electrode layer formed on the organic layer, comprising: aligning a mask having openings corresponding to the predetermined pattern with the substrate on which the first electrode layer is formed; detachably attaching the mask and the substrate; sequentially forming a plurality of the organic material layers on the substrate attached with the

mask in a plurality of vacuum processing chambers; and transferring the mask and the substrate between the vacuum processing chambers in an attached state.

[0008]

Further, a method of forming an organic layer comprises forming each of the organic material layers in a different vacuum processing chamber.

[0009]

Preferably, a method of forming an organic layer comprises placing vapor deposition sources for supplying organic materials for forming the organic material layers to the vacuum processing chambers into states capable of supplying organic materials at predetermined evaporation rates when the substrate and the mask are loaded into the vacuum processing chambers.

[0010]

According to the present invention, there is provided an apparatus for manufacturing an organic electroluminescence display which has a substrate, a first electrode layer formed on the substrate with a predetermined pattern, a organic layer comprised of a plurality of organic material layers stacked on the first electrode layer with a predetermined pattern, and a second electrode layer formed on the organic layer, comprising an alignment mechanism for aligning a mask having openings

corresponding to the predetermined pattern with the substrate on which the first electrode layer is formed and detachably attaching the mask and the substrate; a plurality of vacuum processing chambers for sequentially forming a plurality of the organic material layers on the substrate attached with the mask; and a transferring means for transferring the attached mask and substrate to one of a plurality of the vacuum chambers and sequentially transferring it among the plurality of the vacuum processing chambers.

[0011]

In the present invention, when the mask and the substrate are aligned and attached, the two are loaded into one of the plurality of vacuum processing chambers in the attached state. The vacuum processing apparatus into which these mask and substrate are loaded is in a state capable of forming at least one layer of the plurality of organic material layers composing the organic layer. The organic material layer is formed after the loading is completed.

After forming the at least one of the organic material layers, the attached mask and the substrate are unloaded from the vacuum processing apparatus and then are loaded into another vacuum processing apparatus so that another organic material layer may be stacked. The same process of formation of the organic material layer and the

same transfer of the mask and the substrate are repeated until the organic layer is formed.

In this way, in the present invention, the formation of the plurality of organic layers composing the organic layer is divided among the plurality of vacuum processing apparatuses and the transfer of the substrate between the plurality vacuum processing apparatuses is performed in a state with the mask and the substrate attached. Due to this, alignment between the mask and the substrate is not needed and the time for alignment can be eliminated.

[0012]

[Embodiment of the Invention]

Below, preferred embodiments will be described with reference to the accompanying drawings.

FIG. 1 and FIG. 2 are views of an example of the organic electroluminescence display to which the present invention is applied. Specifically, FIG. 1 is a cross-sectional view of the principal portion of the general configuration of the display area of the organic EL display, while FIG. 2 is a plan view of the principal portion of the general configuration of the display area of the organic EL display. Note that FIG. 1 is a cross-sectional view along the direction of the line A-A′ in FIG. 2. Further, the organic EL display shown in FIG. 1 and FIG. 2 is a so-called active matrix type of color display.

[0013]

The display in FIG. 1 has a substrate 1, a plurality of thin film transistors 2, anode electrodes 10 formed on the transistors 2 via an interlayer insulating layer 7, organic layers 11G, 11R, and 11B which are formed on the anode electrodes 10 and emit colors of green (G), red (R), and blue (B) respectively, a cathode electrode 12 formed on the organic layers 11G, 11R, and 11B, a transparent conductive film 16 formed on the cathode electrode 12, and a substrate 18 fixed on the transparent conductive film 16 via an ultraviolet cured resin layer 17.

Note that each organic EL element, which emits each luminescence color by itself, is configured by an anode electrode 10, an organic layer 11G, 11R, or 11B, and a cathode electrode 12. The pixels PL are configured by these organic EL elements and thin film transistors 2. Light emitted at the organic layer 11G, 11R, or 11B passes through the cathode electrode 12 side to be output through the substrate 18.

Further, as shown in FIG. 2, the pixels PL are arranged in a matrix, while the organic layers 11G, 11R, and 11B are arranged in a regular order.

[0014]

The substrate 1 is formed of an insulating material. For example, a hard member such as a glass substrate or a

pliable member such as a polyamide film or other plastic substrate can be used. Note that the direction of passage of light emitted by the above organic EL element is toward the cathode electrode 12 side, so the substrate 1 need not be a transparent material.

[0015]

In the thin film transistor 2, a gate electrode 3 with a predetermined pattern is formed on the substrate 1, and a polysilicon layer 20 is formed on the gate electrode 3 via a gate insulating layer 5. Further, an interlayer insulating film 4 is formed so as to cover this polysilicon layer 20.

Further, a source region 21 and a drain region 22 are formed on the gate insulating film 5 at the gate electrode 3 side. The source region 21 and the drain region 22 are electrically connected with interconnections 6 through not illustrated contact holes formed in the interlayer insulating film 4.

An interlayer insulating film 7 is formed so as to cover these interconnections 6.

[0016]

Anode electrodes 10 are formed on the interlayer insulating film 7 corresponding to the pixels PL.

The anode electrodes 10 are connected electrically with interconnections 6 through contact holes 8 formed

above the interconnections 6 of the interlayer insulating film 7. As the material, a high reflectance, conductive material with a large work function such as chrome (Cr), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), tantalum (Ta), tungsten (W), platinum (Pt), or gold (Au) can be used.

[0017]

The organic layers 11G, 11R, and 11B are formed on the anode electrodes, and an insulating film 13 is formed so as to cover the periphery of the anode electrodes 10 and enclose the organic layers 11G, 11R, and 11B. The insulating film 13 is formed of for example silicon oxide.

[0018]

Ribs 14 are formed on this insulating film 13. The ribs 14, as shown in FIG. 2, are arranged between each pixel PL in a matrix form and has tapered side walls. The ribs 14 function as spacers of masks used for forming the organic layers 11G, 11R, and 11B on the anode electrodes 10 by vapor deposition. That is, they function to define the distance between the masks and the anode electrodes 10.

Further, each of the ribs 14 is comprised of a insulating material layer 14a projecting from the insulating film 13 and a conductive material layer 14b formed on the top of this insulating material layer 14a.

The insulating material layer 14a is formed of an organic insulating material such as polyimide or an

inorganic insulating material such as silicon oxide.

The conductive material layer 14b forms an auxiliary electrode connected with the cathode electrode 12 and is formed of a relatively low resistance conductive material such as aluminum (Al) or chrome (Cr).

[0019]

FIG. 3 is a cross-sectional view of an example of the structure of the organic layer 11G. The same applies to the organic layers 11R and 11B.

As shown in FIG. 3, the organic layer 11G is configured with for example a positive hole injection layer 11a formed on the anode electrode 10, a positive hole transfer layer 11b stacked on this positive hole injection layer 11a, and a light emitting layer 11c stacked on the positive hole transfer layer 11b serving as an electron transfer layer. The light emitting layer 11c is covered by the cathode electrode 12.

[0020]

The positive hole injection layer 11a, the positive hole transfer layer 11b, and the light emitting layer 11c are formed to predetermined thicknesses by vapor depositing organic materials corresponding to the colors of light emitted.

As the organic material of the positive hole injection layer 11a, for example, m-MTDATA[4-4′-4″-tris(3-

methylphenylphenylamino)triphenylamine] can be used. The thickness of the positive hole injection layer 11a is for example about 30 nm.

As the organic material of the positive hole transfer layer 11b, α-NPD[4,4-bis(N-1-naphthyl-N-phenylamino)biphenyl] or the like can be used. The thickness of the organic material of the positive hole transfer layer 11b is for example about 20 nm.

As the organic material of the light emitting layer 11c, Alq3[tris(8-quinolinolato)aluminum (III)] or the like can be used. The thickness of the light emitting layer 11c is for example about 50 nm.

[0021]

The cathode electrode 12 is formed commonly for the pixels PL, covers the surface of the ribs 14, and is connected with the conductive material layers 14b consisting of the top portions of the ribs 14. Further, the cathode electrode 12 is insulated from the anode electrodes 10 by the organic layers 11G, 11R, and 11B and the insulating film 13.

This cathode electrode 12 is a thin metal film having a small work function and higher transmittance such as magnesium (Mg)-silver (Ag) alloy formed by deposition from binary vapors to a predetermined thickness. The thickness of the cathode electrode 12 is for example about 10 nm.

[0022]

The transparent conductive film 16 is formed so as to cover the cathode electrode 12. This transparent conductive film 16 is formed to a predetermined thickness for example by sputtering. As the material forming it, a material exhibiting good conductivity by formation under ordinary temperature such as an indium (In)-zinc (Zn)-oxygen (O)-based material can be used. The thickness of the transparent conductive film 16 is for example about 200 nm.

[0023]

The substrate 18 is formed of a transparent material. This is to allow passage of the light emitted from the light emitting layer 11c of the organic layers 11G, 11R, and 11B and striking the substrate through the transparent layer 16. For example, a hard member such as a glass substrate or a pliable member such as a polyamide film or other plastic substrate can be used.

[0024]

FIG. 4 is a view of the configuration of an apparatus for manufacturing an organic EL display according to an embodiment of the present invention.

The apparatus for manufacturing the organic EL display 40 forms the above organic layers 11G, 11R, and 11B, the cathode electrode 12, and the transparent conductive film 16.

As shown in FIG. 4, the manufacturing apparatus 40 is configured with a loading unit 50, a green organic layer formation unit 60, a red organic layer formation unit 70, a blue organic layer formation unit 80, and an electrode formation unit 90.

[0025]

The loading unit 50 has a substrate loading chamber 51, a pre-processing chamber 52, a mask loading chamber 53, an alignment chamber 54, a transfer work chamber 55, a transfer chamber 56, and a jig loading chamber 57.

The substrate loading chamber 51, the pre-processing chamber 52, the mask loading chamber 53, the alignment chamber 54, the transfer work chamber 55, the transfer chamber 56, and the jig loading chamber 57 are configured by vacuum chambers capable of being evacuated inside to a substantive vacuum atmosphere. Further, the substrate loading chamber 51, the pre-processing chamber 52, the mask loading chamber 53, the alignment chamber 54, the jig loading chamber 57, and the transfer chamber 56 are connected to the circumference of the transfer work chamber 55 via gates Gt. The gates Gt are opened and closed by not illustrated gate valves. Further, these gate valves are controlled so as to be opened and closed in response to operations of transfer robots 45.

[0026]

The substrate loading chamber 51 can be loaded with a substrate 1 on which the organic layers 11G, 11R, and 11B, the cathode electrode 12, and transparent conductive film 16 should be formed.

The substrate loading chamber 51 is a so-called load locked chamber.

FIG. 5 is a cross-sectional view of a principal portion of the configuration of a substrate 1 to be loaded into the substrate loading chamber 51.

As shown in FIG. 5, ribs 14 functioning as spacers project above the substrate 1.

Further, the surfaces of the anode electrodes 10 surrounded by the ribs 14 are exposed.

[0027]

The pre-processing chamber 52 treats the surfaces of the anodes 10 and ribs 14 in the state of the substrate 1 shown in FIG. 5. For example, it treats the surface of the substrate 1 by oxygen plasma. Further, it may treat it by ultraviolet ozone.

[0028]

The mask loading chamber 53 is loaded with a mask aligned with and attached (integrally) to the substrate 1. The mask loading chamber 53 is a so-called load locked chamber.

FIG. 6 is a perspective view of an example of the

structure of the mask and the attachment jig for attaching it to the substrate 1.

As shown in FIG. 6, the mask 200 is formed of a plate-shaped member with a rectangular contour. The mask 200 is formed of a magnetic substance such as iron or nickel.

This mask 200 has larger dimensions than that of the substrate 1 and is formed with a plurality of openings corresponding to patterns of the organic layers 11R, 11G, and 11B in a mask portion 202 surrounded by an outer frame portion 202. The mask can be used in common for the formation of the organic layers 11R, 11G, and 11B.

That is, the organic layers 11R, 11G, and 11B are regularly arranged on the substrate 1, so it is possible to adjust the alignment between the mask 200 and the substrate 1 to position the openings of the mask 200 at the positions of formation of the organic layers 11R, 11G, and 11B of the substrate 1.

[0029]

The attachment jig 100 includes a magnet plate 101 having substantially the same dimensions as the contour of the substrate 1 and grip portions 102 connected to the ends of the magnet plate 101.

Parts of the grip portions 102 extend to the sides of the magnet plate 101 so as to project from the ends. These

grip portions 102 can be held by arms of the below described transfer robots 45.

The magnet plate 101 is able to attract the mask 200 by magnetic force.

In FIG. 6, the surface of the magnet plate 101 facing the non-film-formation surface 1a side of the substrate 1 forms a contact surface 101a coming into full contact with the non-film-formation surface 1a of the substrate 1.

[0030]

The substrate 1 and the mask 200 can be attached (integrally) by bringing the contact surface 101a of the magnet plate 101 into contact with the non-film-formation surface 1a of the substrate 1 in the state with the film-formation surface 1b of the substrate 1 facing the mask 200 and the two aligned.

When the contact surface 101a of the magnet plate 101 contacts the non-film-formation surface 1a of the substrate 1, the mask 200 formed of a magnetic substance is attracted to the magnet plate 101 via the substrate 1.

Further, the mask portion 201 of the mask 200 is attracted to the film-formation surface 1b by the magnetic force without slack of the mask portion 201.

[0031]

The jig loading chamber 57 is loaded with the above attachment jig 100. The jig loading chamber 57 is a load

lock chamber.

[0032]

The transfer work chamber 55 is provided with the transfer robot 45 inside. This transfer robot 45 is provided with a plurality of arms 45a, 45b, and 45c connected pivotally in the horizontal direction. Further, the tip of the arm 45a is provided with a holder 45d capable of holding the above substrate 1, the mask 200, and the attachment jig 100. Furthermore, the transfer robot 45 includes a mechanism capable of elevating the plurality of arms 45a, 45b, and 45c in the vertical direction.

This transfer robot 45 is controlled to transfer the substrate 1, the mask 200, and the attachment jig 100.

[0033]

The alignment chamber 54 is provided with an alignment mechanism for the alignment between the above substrate 1 and the mask 200 and the attachment between the substrate 1 and the mask 200 using the attachment jig 100.

FIG. 7 is a view of the structure of the alignment chamber 54. Note that the below described alignment chambers 71 and 81 and the substrate/mask separating chamber 93 also include alignment mechanisms as same as the alignment mechanism shown in FIG. 7.

[0034]

As shown in FIG. 7, the alignment chamber 54 is

provided with a jig holder 310 arranged at the upper portion inside a partition wall 300, a substrate holder 314 below this jig holder 310, and mask holders 320 arranged at the two sides of the substrate holder 314.

[0035]

The jig holder 310 is provided with holder portions 310a at the lower ends. The grip portions 102 of the attachment jig 100 are held by these holder portions 310a. This jig holder 310 is connected with an elevation mechanism 330 arranged at the upper portion outside of the partition wall 300 via a connecting rod 311.

This elevation mechanism 330 elevates the jig holder 310 in the vertical direction (z-direction). The elevation mechanism 330 is comprised of for example a servo motor, a transmission mechanism, etc.

[0036]

The substrate holder 314 is provided with a connecting part 315 connected to a rotatable shaft 317, a plurality of supports 316 standing at the two ends of this connecting part 315 and can support the periphery of the film-formation surface 1b of the substrate 1 by the tips of the support 316. Note that the supports 316 can be inserted into holes formed at the four corners of the mask portion 201 of the mask 200 shown in FIG. 6.

[0037]

The rotatable shaft 317 connected to the substrate holder 314 is connected to a movement/rotation mechanism 340 arranged at the outside of the bottom of the partition wall 300.

This movement/rotation mechanism 340 holds the substrate holder 314 rotatably in the rotational direction θ around the rotatable shaft 317 and movably holds the substrate holder 314 in the z-direction and the x- and y-direction perpendicularly intersecting the z-direction. The movement/rotation mechanism 340 is comprised of example a servo motor, a transmission mechanism, etc.

[0038]

The mask holders 320 can support the two ends of the bottom surface of the above mask 200. Each mask holder 320 is connected to an elevation mechanism 350 via a connecting rod 321. The elevation mechanism 350 holds the mask holder 320 movably in the z-direction. Note that the elevation mechanism 350 is shown split in FIG. 7, but is actually a single mechanism and simultaneously elevates the mask holders 320.

[0039]

The transfer chamber 56 comprises a loading path for loading the substrate 1 and the mask 200 attached by the attachment jig 100 in the alignment chamber 54 to the green organic layer formation unit 60.

[0040]

The green organic layer formation unit 60 forms the green organic layer 11G. This green organic layer formation unit 60 includes a transfer work chamber 61 and a plurality of vapor deposition processing chambers 62, 63, and 64. The transfer work chamber 61 and a plurality of vapor deposition processing chambers 62, 63, and 64 are comprised by vacuum chambers capable of being evacuated inside to a substantive vacuum atmosphere. Further, the vapor deposition processing chambers 62, 63, and 64 are connected to the circumference of the transfer work chamber 61 via gates Gt.

[0041]

The above configured transfer robot 45 is arranged in the transfer work chamber 61. This transfer robot 45 transfers the substrate 1 and the mask 200 between the vapor deposition processing chambers 62, 63, and 64 and to the red organic layer formation unit 70.

[0042]

The vapor deposition processing chamber 62 forms the hole injection layer 11a of the organic layer 11G.

The vapor deposition processing chamber 63 forms the hole transfer layer 11b of the organic layer 11G.

The vapor deposition processing chamber 64 forms the light emitting layer 11c of the organic layer 11G.

[0043]

FIG. 8 is a cross-sectional view of an example of the configuration of the vapor deposition processing chambers 62, 63, and 64.

Note that the vapor deposition processing chambers 73, 74, and 75 in the below described red organic layer formation unit 70 and the vapor deposition processing chambers 83, 84, and 85 in the below described blue organic layer formation unit 80 also have basically the same configurations with the configuration shown in FIG. 8.

[0044]

As shown in FIG. 8, a jig holder 401 is arranged at the top of the inside of the partition wall 400 and is capable of holding the attachment jig 100 attaching the substrate 1 to the mask 200.

This jig holder 401 is provided with a holding portions 401a holding the grip portions 102 of the attachment jig 100 at its lower ends.

Further, the jig holder 401 is connected with a rotatable shaft 402. The rotatable shaft 402 is connected to the rotating mechanism 430 arranged at the top outside of the partition wall 400.

[0045]

The rotating mechanism 430 rotates the rotatable shaft 402 at a predetermined speed at the time of vapor

deposition. The rotating mechanism 430 is comprised of example a servo motor, a transmission mechanism, etc.

[0046]

When the rotatable shaft 402 is rotated by the rotating mechanism 430, the substrate 1 and the mask 200 also rotate around the rotatable shaft 402.

Under the partition wall 400 is arranged a heating vessel 420 holding a vapor deposition material Vs comprised of the above described organic material.

This heating vessel is provided with an opening 420a on the top end. A shutter 440 opening and closing the opening 420a is arranged above this opening 420a. The shutter 440 is driven by a not illustrated movement mechanism in the opening and closing directions C1 and C2. This shutter 440 is arranged for preventing wasted consumption of the organic material by closing the opening 420a when not performing vapor deposition.

[0047]

An induction coil 421 is built into the heating vessel 420. This induction coil 421 is connected with an alternating current supply 422.

By supplying an alternating current to the induction coil 421 from the alternating current supply 422, the heating vessel 420 itself is heated by electromagnetic field generated from the induction coil 421. By this, the

vapor deposition material Vs accommodated in the heating vessel 420 is evaporated.

Note that the alternating current supply 422 can control the temperature of the heating vessel 420 by adjusting the supplied current.

[0048]

The red organic layer formation unit 70 forms the organic layer 11R. This red organic layer formation unit 70 includes an alignment chamber 71, a transfer work chamber 72, and a plurality of vapor deposition processing units 73, 74, and 75. The transfer work chamber 72 and vapor deposition processing units 73, 74, and 75 are configured by vacuum chambers capable of being evacuated inside them to a substantive vacuum atmosphere. Further, the vapor deposition processing units 73, 74, and 75 are connected to the circumference of the transfer work chamber 72 via the gates Gt.

[0049]

The alignment chamber 71 includes the same alignment mechanism as the alignment chamber 54 of the loading unit 50. This alignment chamber 71 separates the substrate 1 and the mask 200 attached state in the alignment chamber 54, realigns the substrate 1 and the mask 200, and reattaches the substrate 1 and the mask 200 by the attachment jig 100.

[0050]

The above configured transfer robot 45 is arranged in the transfer work chamber 72. This transfer robot 45 transfers the substrate 1 and the mask 200 between the vapor deposition processing units 73, 74, and 75 and to the blue organic layer formation unit 80.

[0051]

The vapor deposition processing chamber 73 forms the hole injection layer 11a of the organic layer 11 R.

The vapor deposition processing chamber 74 forms the hole transfer layer 11b of the organic layer 11 R.

The vapor deposition processing chamber 73 forms the light emitting layer 11c of the organic layer 11 R.

[0052]

The blue organic layer formation unit 80 forms the organic layer 11B. This blue organic layer formation unit 80 includes an alignment chamber 81, a transfer work chamber 82, and a plurality of vapor deposition processing units 83, 84, and 85.

[0053]

The alignment chamber 81 includes the same alignment mechanism as the alignment chamber 71 of the red organic layer formation unit 70. This alignment chamber 81 separates the substrate 1 and the mask 200 attached in the alignment chamber 71, realigns the substrate 1 and the mask 200, and reattaches the substrate 1 and the mask 200 by the

attachment jig 100.

[0054]

The above configured transfer robot 45 is arranged in the transfer work chamber 82. This transfer robot 45 can transfer the substrate 1 and the mask 200 between the vapor deposition processing units 83, 84, and 85 and to the electrode formation unit 90.

[0055]

The vapor deposition processing chamber 83 forms the hole injection layer 11a of the organic layer 11 B.

The vapor deposition processing chamber 84 forms the hole injection transfer layer 11b of the organic layer 11B.

The vapor deposition processing chamber 85 forms the light emitting layer 11c of the organic layer 11 B.

[0056]

The electrode formation unit 90 includes a loading chamber 91, a transfer work chamber 92, a substrate/mask separation chamber 93, an electrode formation unit 94, a sputtering chamber 95, a substrate unloading chamber 96, and a jig/mask unloading chamber 97. The loading chamber 91, the transfer work chamber 92, the substrate/mask separation chamber 93, the electrode formation unit 94, the sputtering chamber 95, the substrate unloading chamber 96, and the jig/mask unloading chamber 97 are configured by vacuum chambers capable of being evacuated inside to a substantive

vacuum atmosphere. Further, the loading chamber 91, the transfer work chamber 92, the substrate/mask separation chamber 93, the electrode formation unit 94, the sputtering chamber 95, the substrate unloading chamber 96, and the jig/mask unloading chamber 97 are connected to the circumference of the transfer work chamber 92 via the gates Gt.

[0057]

The loading chamber 91 comprises a loading path for loading the substrate 1 and the mask 200 after the formation of the organic layer 11B in the blue organic layer formation unit 80 to the transfer work chamber 92.

[0058]

The substrate/mask separation chamber 93 includes the same alignment mechanism as the above alignment chambers 54, 71, and 81. This substrate/mask separation chamber 93 separates the substrate 1 and the mask 200 attached by the attachment jig 100 by the alignment mechanism.

[0059]

The electrode formation chamber 94 is provided with a vapor deposition apparatus for forming the above cathode electrode 12 on the substrate 1 after being separated from the mask 200. Note this vapor deposition apparatus is a well-known vapor deposition apparatus, so a detailed explanation of the vapor deposition apparatus will be

omitted.

[0060]

The sputtering chamber 95 forms the above transparent conductive film 16 on the substrate 1 after the cathode electrode 12 is formed by sputtering. The sputtering chamber 95 is provided, for example, with a direct current sputtering apparatus. Note that the direct current sputtering apparatus is well known, so a detailed explanation of the direct current sputtering apparatus will be omitted.

[0061]

The substrate unloading chamber 96 is a vacuum chamber for unloading the substrate 1 after the transparent conductive film 16 is formed from the electrode formation unit 90.

The jig/mask unloading chamber 97 is a vacuum chamber for unloading the mask 200 and the attachment jig 100 after being separated from the substrate 1 from the electrode formation unit 90.

[0062]

The transfer work chamber 92 is provided with the above configured transfer robot 45. This transfer robot 45 transfers the substrate 1, the mask 200, and the attachment jig 100.

[0063]

Next, an explanation will be made of a method of manufacturing an organic EL display using the above manufacturing apparatus 40.

First, the necessary number of substrates 1 in the state shown in FIG. 5 are loaded into the substrate loading chamber 57 in advance. Further, the necessary number of the masks 200 are loaded into the mask loading chamber 53 in advance. Furthermore, the necessary number of attachment jigs 100 are loaded into the jig loading chamber 57.

[0064]

On the other hand, the heating vessel 420 of each of the green organic layer formation unit 60, the red organic layer formation unit 70, and the blue organic layer formation unit 80 is heated in advance so that the temperature of the vapor deposition material Vs is controlled so as to be evaporated at a constant evaporation rate. Note that the heating vessel 420 is closed by the shutter 440 in advance. Further, it is preferable that the evaporation rate in each of the green organic layer formation unit 60, the red organic layer formation unit 70, and the blue organic layer formation unit 80 be controlled in accordance with the time for forming a film in the evaporating chamber which forms the thickest layer. That is, the cycle time in an organic layer formation process depends on the time for forming the thickest layer.

[0065]

Next, the gate valve of the substrate loading chamber 57 is opened to load the substrate 1 in the substrate loading chamber 57 into the pre-processing chamber 52 by the transfer robot 45.

The pre-processing chamber 52 uses oxygen plasma to treat the substrate 1 under the conditions of for example 400 sccm, 50W of a high frequency power, and 120 sec of treatment time.

[0066]

On the other hand, before the completion of this oxygen plasma treatment, as shown in FIG. 9, the attachment jig 100 in the jig loading chamber 57 is held by the holder 45d of the transfer robot 45 and loaded into the alignment chamber 54.

In FIG. 9, the grip portions 102 of the attachment jig 100 loaded into the alignment chamber 54 through the gate Gt are positioned to be able to be held by the holder portions 310a of the jig holder 310.

Further, as shown in FIG. 10, the jig holder 310 is elevated to a predetermined position by the elevation mechanism 330. By the elevation of the jig holder 310, the attachment jig 100 is separated from the holder 45d of the transfer robot 45 so that the attachment jig 100 is held by the jig holder 310.

[0067]

Further, as shown in FIG. 10, after the completion of the transfer of the attachment jig 100 to the alignment chamber 54, the transfer robot 45 loads the mask 200 in the mask loading chamber 53 into the alignment chamber 54.

The loading position of the mask 200 is between the attachment jig and the mask holder 320.

[0068]

From this state, as shown in FIG. 11, the mask holder 320 is elevated to a predetermined position by the elevation mechanism 350. By the elevation of the mask holder 320, the mask 200 is separated from the holder of the transfer robot 45 and held by the mask holder 320.

[0069]

Next, in the state with the attachment jig 100 held by the jig holder 310 and the mask 200 held by the mask holder 320, as shown in FIG. 12, the substrate 1 finished being treated on its surface in the pre-processing chamber 52 is loaded into the alignment chamber 54 by the transfer robot 45.

As shown in FIG. 12, before loading the substrate 1 into the alignment chamber 54, the mask holder 320 is lowered to a predetermined position and a space is formed where there is no interference with the substrate 1 between the attachment jig 100 and the mask 200.

[0070]

Next, as shown in FIG. 13, the substrate holder 314 is elevated to a predetermined position by the movement/rotation mechanism 340. By the elevation of the substrate holder 314, the substrate 1 is separated from the holder 45d of the transfer robot 45 and held by the supports 316.

Due to this, the attachment jig 100 is held by the jig holder 310, the mask 200 is held by the mask holder 320, and the substrate 1 is held by the substrate holder 314.

[0071]

Next, by adjusting the rotational position of the substrate 1 in the θ direction and the position in the X- and Y-directions by the movement/rotation mechanism 340 from the above state, the substrate 1 and mask 200 are aligned. This alignment work is based on the information of the position and posture of the substrate 1 with respect to the mask 200 obtained by image processing of the images of the mask 200 and substrate 1 taken by for example a not illustrated image pickup device.

Further, as shown in FIG. 14, the alignment is performed so that the opening 200h of the mask 200 is located at the position of formation of the organic layer 11G to be formed on the substrate 1.

[0072]

After the completion of the alignment work between the substrate 1 and the mask 200, as shown in FIG. 15, the mask holder 320 is elevated to a predetermined position to bring the substrate 1 into contact with the mask 200 and place the substrate 1 on the mask 200.

[0073]

From this state, as shown in FIG. 16, the mask holder 320 is further elevated to bring the substrate 1 into contact with the attachment jig 100. Due to this, the mask 200 is attracted to the magnet plate 101 by the magnetic force of the magnet plate 101 so that the mask 200 and the substrate 1 are attached and alignment is maintained.

Further, by the attachment of the mask 200 and the substrate 1, as shown in FIG. 14, the mask 200 contacts the tops of the ribs 14 so that the distance between the mask 200 and the anode electrode 10 is maintained constant.

[0074]

Next, as shown in FIG. 16, in the state with the attached attachment jig 100, substrate 1, and mask 200 held by the mask holder 320, the holder 45d of the transfer robot 45 is inserted below the mask 200. Further, by lowering the mask holder 320, the attached attachment jig 100, substrate 1, and mask 200 become held by the jig holder 310. In this state, by lowering the jig holder 310 to a predetermined position, the attached attachment jig

100, substrate 1, and mask 200 are placed on the holder 45d of the transfer robot 45.

[0075]

Next, the attached attachment jig 100, substrate 1, and mask 200 placed on the holder 45d of the transfer robot 45 are transferred to the transfer chamber 56.

[0076]

Next, the attached attachment jig 100, substrate 1, and mask 200 transferred to the transfer chamber 56 are transferred to the vapor deposition processing chamber 62 by the transfer robot 45 arranged in the transfer work chamber 61.

[0077]

As shown in FIG. 17, the attached attachment jig 100, substrate 1, and mask 200 transferred inside the partition wall 400 of the vapor deposition processing chamber 62 through the gate Gt are held by the jig holder 401 by lowering the holder portion 45d of the transfer robot 45 to a predetermined position.

[0078]

After the substrate 1 and the mask 200 are held by the jig holder 401, as shown in FIG. 18, the jig holder 401 is made to rotate at a predetermined rotational speed and the shutter 440 is opened for the vapor deposition to form the hole injection layer 11a of the organic layer 11G to a

predetermined thickness. The time for forming the hole injection layer 11a is determined by the vapor deposition rate.

Further, by rotating the substrate 1 and the mask 200, the hole injection layer 11a is formed to a uniform thickness.

[0079]

After forming the hole injection layer 11a, the same procedure as the above is used to transfer the attached attachment jig 100, substrate 1, and mask 200 to the vapor deposition processing chamber 63 by the transfer robot 45 provided in the transfer work chamber 61 to form the hole transfer layer 11b of the organic layer 11G.

The light emitting layer 11c of the organic layer 11G is formed in the vapor deposition processing chamber 64 in the same way.

As a result, the organic layer 11G comprised of the hole injection layer 11a, the hole transfer layer 11b, and the light emitting layer 11c is formed stacked on the anode electrodes 10 of the substrate 1.

[0080]

Next, the substrate 1 formed with the organic layer 11G is transferred to the alignment chamber 71 of the red organic layer formation unit 70 in the state attached to the mask 200.

As shown in FIG. 19, after the substrate 1 and the mask 200 attached by the attachment jig 100 is loaded into the alignment chamber 71 by the holder 45 of the transfer robot 45, the mask holder 320 is elevated to a predetermined position to separate the mask 200 from the holder 45d and hold them by the mask holder 320.

[0081]

Next, as show in FIG. 20, the jig holder 310 is elevated to a predetermined position. By this elevation of the jig holder 310, only the attachment jig 100 is separated from the substrate 1 and the mask 200.

From the state with only the attachment jig 100 separated from the substrate 1 and the mask 200, the substrate holder 314 is elevated to a predetermined position. Due to the elevation of the substrate holder 314, the substrate 1 and the mask 200 are separated.

Due to this, the attachment jig 100 is held by the jig holder 310, the mask is held by the mask holder 320, and the substrate 1 is held by the substrate holder 314.

[0082]

From this state, in the same way with the operation explained with reference to FIG. 15 and FIG. 16, the substrate 1 and the mask 200 are realigned.

In the alignment chamber 71, as shown in FIG. 21, an alignment is performed so that the opening 200h of the mask

200 is located at the position of formation of the organic layer 11R to be formed on the substrate 1.

[0083]

After completing the alignment, the same procedure is used as in the operation explained with reference to FIG. 15 and FIG. 16 to reattach the substrate 1 and the mask 200 by the attachment jig 100 and sequentially transfer the substrate 1 and the mask 200 in the attached state to the vapor deposition processing chambers 73, 74, and 75 to form the hole injection layer 11a, the hole transfer layer 11b, and the light emitting layer 11c of the organic layer 11R.

[0084]

After forming the organic layer 11R, the attached substrate 1 and mask 200 are transferred into the alignment chamber 81 and, in the same way as the operation in the alignment chamber 71, the substrate 1 and the mask 200 are aligned reattached by the attachment jig 100.

In the alignment chamber 81, as shown in FIG. 21, alignment is performed so that the opening 200h of the mask 200 is located at the position of formation of the organic layer 11R to be formed on the substrate 1.

After completing the alignment, the same procedure is used as the operation explained with reference to FIG. 15 and FIG. 16 to reattach the substrate 1 and the mask 200 by the attachment jig 100 and sequentially transfer the

attached substrate 1 and the mask 200 to the vapor deposition processing chambers 83, 84, and 85 to form the hole injection layer 11a, the hole transfer layer 11b, and the light emitting layer 11c of the organic layer 11B.

[0085]

After forming the organic layer 11B, the attached substrate 1 and the mask 200 are transferred to the electrode formation unit 90.

In the electrode formation unit 90, the attached substrate 1 and mask 200 are first loaded into the substrate/mask separation chamber 93.

[0086]

In the substrate/mask separation chamber 93, the attached substrate 1 and the mask 200 are separated. Note that the substrate/mask separation chamber 93 is provided with the same alignment mechanism as the alignment chamber 81 or the like. By operating this alignment mechanism by a predetermined procedure, it becomes possible to separate the attachment jig 100, the substrate 1, and the mask 200.

[0087]

After separating the substrate 1 and the mask 200, the substrate 1 is transferred to the electrode formation chamber 94, while the attachment jig 100 and the mask 200 are transferred to the jig/mask unloading chamber 97.

[0088]

In the electrode formation chamber 94, the cathode 12 is formed by vapor deposition. Specifically, by co-deposition of for example magnesium (Mg) and silver (Ag), a cathode electrode 12 comprised of Mg-Ag alloy is formed. The film thickness is for example about 10 nm. Further, the ratio of the film formation speed between the Mg and Ag is made for example 9:1.

[0089]

Next, after forming the cathode electrode 12 on the organic layers 11G, 11R, and 11B of the substrate 1, the substrate 1 is loaded into the sputtering chamber 95, then the transparent conductive layer 16 is formed on the cathode electrode 12. The film formation conditions are as follows: a sputtering gas of a mixed gas of for example argon (Ar) and oxygen (O_2) (volume ratio of Ar/O_2 = 1000), a pressure of about 0.3 Pa, and an output of the direct current sputtering apparatus of 40W.

[0090]

Next, after forming the transparent conductive film 16, the substrate 1 is loaded into the substrate unloading chamber 96. The substrate 1 transferred to the substrate unloading chamber 96 is unloaded from the substrate unloading chamber 96, then fixed to the substrate 18 via the ultraviolet cured resin layer 17. By this, the assembly of the organic EL display is completed.

[0091]

Further, the mask 200 and the attachment jig 100 separated in the substrate/mask separation chamber 93 are transferred to the jig/mask unloading chamber 97.

The mask 200 and the attachment jig 100 loaded to the jig/mask unloading chamber 97 are unloaded from the jig/mask unloading chamber 97, then reused.

Note that by inspecting whether there is a defect in the mask 200 before reuse, it becomes possible to avoid reusing a mask 200 with a defect and prevent an inferior organic EL display from being manufactured.

[0092]

As described above, according to the present embodiment, by dividing the formation of the organic layers 11G, 11R, and 11B comprised of the plurality of the organic material layers among different vapor deposition processing chambers, it is possible to suppress waste of the organic material used for vapor deposition.

Further, according to the present embodiment, since the plurality of organic material layers are formed continuously in the state with the substrate 1 and the mask 200 aligned and attached, the time for the alignment in each of the vapor deposition processing chambers becomes unnecessary, so the cycle time can be shortened.

Furthermore, according to the present embodiment,

since no alignment mechanism is needed in each vapor deposition processing chamber, it becomes possible to reduce the equipment costs.

Furthermore, according to the present embodiment, because of using the mask 200 for each substrate 1, it becomes possible to manufacture different types of organic EL displays in the same assembly line.

[0093]

The present invention is not limited to the above described embodiment.

In the above embodiment, a configuration where a single vapor deposition source is arranged in the vapor deposition chamber and only one organic material layer is formed in one vapor deposition chamber is employed, but it also is possible to employ a configuration where a plurality of vapor deposition sources are arranged in a vapor deposition chamber and a plurality of organic material layers are formed in one vapor deposition chamber.

For example, when there is an organic material layer taking an extremely long time to be formed, by arranging a single vapor deposition source for this organic material layer to form only this organic material layer taking a long time to be formed and arranging a plurality of vapor deposition sources for the other organic material layers taking a short time to be formed, it becomes possible to

prevent the cycle time from being extended.

Furthermore, in the above described embodiment, the explanation was given with reference to the case of an organic layer comprised of three stacked organic material layers, but by applying the present invention to an organic layer comprised of more stacked organic material layers, a greater effect will be obtained from the viewpoint of productivity and the consumption of the organic materials.

Furthermore, in the above described embodiment, when the work in each chamber has no influence on the work in the other chambers, it is unnecessary to partition off the chambers by the gates Gt.

Further, the arrangement of the chambers is not limited to a cluster arrangement. It is possible to select from a straight arrangement, a U-shaped arrangement, or other preferable arrangements in accordance with the order of work.

[0094]

[Effect of the Invention]

According to the present invention, it is possible to shorten the cycle time of the process for forming the organic layer of an organic EL display, so mass production of the organic EL display becomes possible.

Further, according to the present invention, it is possible to suppress waste of the organic materials used

for forming the organic layer, so the costs of producing the organic EL display can be reduced.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1]

A cross-sectional view of an example of the organic EL display to which the present invention is applied showing a principal portion of the general configuration of the display area of the organic EL display.

[Fig. 2]

A plan view of an example of the organic EL display to which the present invention is applied showing a principal portion of the general configuration of the display area of the organic EL display.

[Fig. 3]

A cross-sectional view of an example of the structure of an organic layer.

[Fig. 4]

A view of the configuration of the apparatus for manufacturing an organic EL display according to an embodiment of the present invention.

[Fig. 5]

A cross-sectional view of the configuration of the substrate before formation of the organic layer.

[Fig. 6]

A perspective view of an example of the structure of

the mask and the attachment jig attaching it to the substrate.

[Fig. 7]

A view of the structure of the alignment chamber.

[Fig. 8]

A cross-sectional view of an example of the configuration of the vapor deposition processing chamber.

[Fig. 9]

An explanatory view of an example of the operational procedure of the alignment mechanism in the alignment chamber.

[Fig. 10]

An explanatory view of the operational procedure of the alignment mechanism following FIG. 9.

[Fig. 11]

An explanatory view of the operational procedure of the alignment mechanism following FIG. 10.

[Fig. 12]

An explanatory view of the operational procedure of the alignment mechanism following FIG. 11.

[Fig. 13]

An explanatory view of the operational procedure of the alignment mechanism following FIG. 12.

[Fig. 14]

A view of the state of aligning the mask to the

position of formation of an organic layer on the substrate.

[Fig. 15]

An explanatory view of the operational procedure of the alignment mechanism following FIG. 13.

[Fig. 16]

An explanatory view of the operational procedure of the alignment mechanism following FIG. 15.

[Fig. 17]

An explanatory view of the state of the attached substrate and the mask loaded into the vapor deposition processing chamber.

[Fig. 18]

An explanatory view of the state of vapor deposition in the vapor deposition processing chamber.

[Fig. 19]

An explanatory view of an example of the operational procedure of the alignment mechanism in the alignment chamber.

[Fig. 20]

An explanatory view of the operational procedure of the alignment mechanism following FIG. 19.

[Fig. 21]

A view of the state of aligning the mask to the position of formation of an organic layer on the substrate.

[Fig. 22]

A view of the state of aligning the mask to the position of formation of an organic layer on the substrate.

[Description of References]

1... substrate; 40... apparatus for forming an organic layer; 45... transfer robot; 50... loading unit; 51... substrate loading chamber; 52... pre-processing chamber; 53... mask loading chamber; 54... alignment chamber; 55... transfer work chamber; 56... transfer chamber; 57... jig loading chamber; 60... green organic layer formation; 61... transfer work chamber; 62, 63, 64... vapor deposition processing chamber; 70... red organic layer formation unit; 71... alignment chamber; 72... transfer work chamber; 73, 74, 75... vapor deposition processing chamber; 80... blue organic layer formation unit; 81... alignment chamber; 82... transfer work chamber; 83, 84, 85... vapor deposition processing chamber; 90... electrode formation unit; 91... loading chamber; 92... transfer work chamber; 93... substrate/mask separating chamber; 94... electrode formation unit; 95... sputtering chamber; 96... substrate unloading chamber; 97... jig/mask unloading chamber; 100... attachment jig; 200... mask 200; 300... partition wall; 310... jig holder; 314... substrate holder; 320... mask holders; 400... partition wall; 401... jig holder; 402... rotatable shaft; 430... rotating mechanism; 420... heating vessel; and Vs... vapor

deposition material.

NAME OF DOCUMENT DRAWINGS

FIG. 1

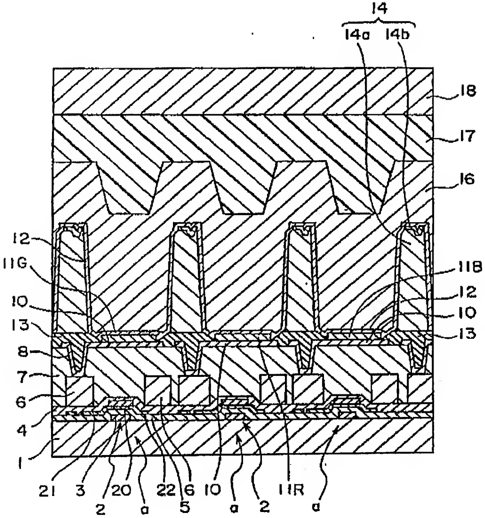


Fig. 2

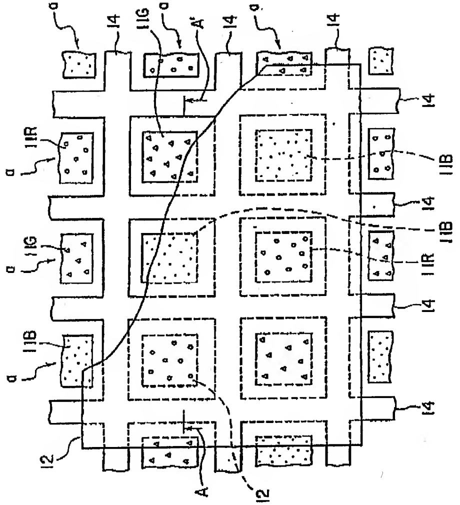


Fig. 3

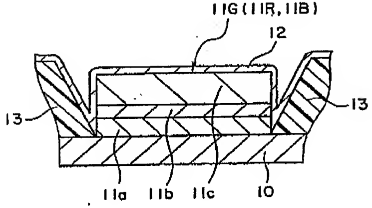
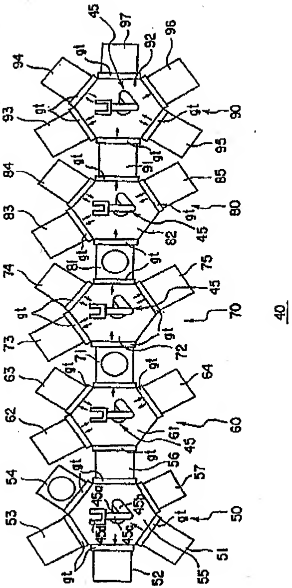


Fig. 4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51
52
55
45a
45b
45c
45d
gt
40

Fig. 5

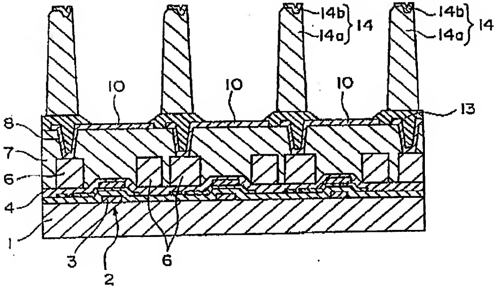


Fig. 6

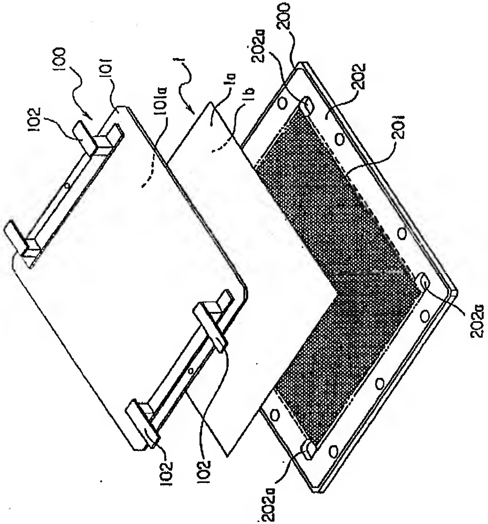


Fig. 7

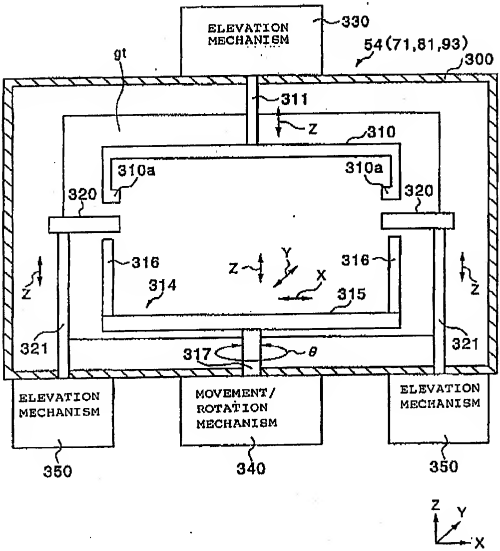

ELEVATION MECHANISM
330
54(71,81,93)
300
gt
311
Z
310
310a
310a
320
320
316
316
Z
Y
X
314
315
Z
Z
321
321
317
θ
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350
Z
Y
X

Fig. 8

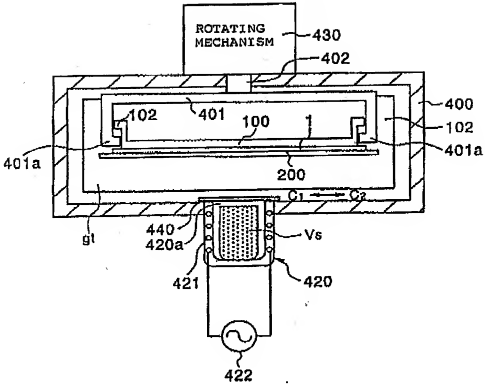
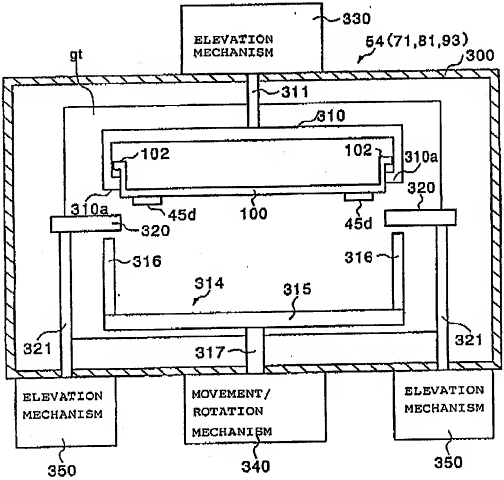

ROTATING MECHANISM
430
402
400
102
401a
102
401
100
1
401a
200
C1
C2
gt
440
420a
Vs
421
420
422

Fig. 9


330
ELEVATION MECHANISM
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gt
311
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102
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316
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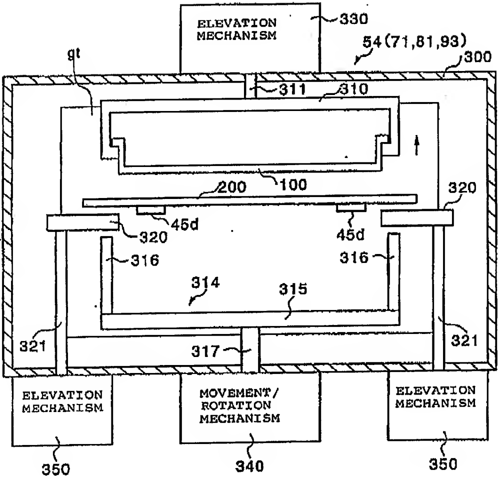
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350

Fig. 10


ELEVATION MECHANISM
330
54(71,81,93)
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gt
311
310
100
200
320
45d
320
45d
316
316
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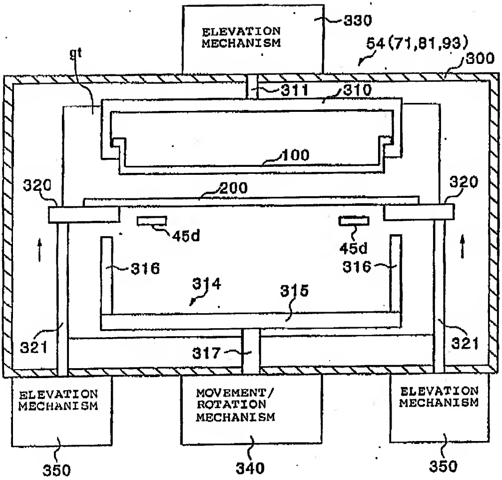
317
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350

Fig. 11


ELEVATION MECHANISM
330
54(71,81,93)
300
91
311
310
100
320
200
320
45d
45d
316
316
314
315
321
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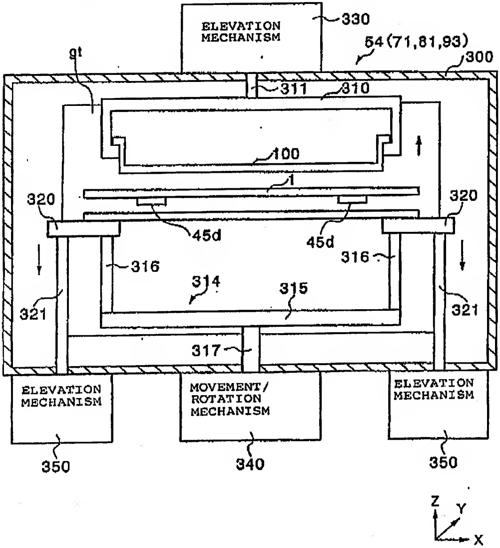
317
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350

Fig. 12


ELEVATION MECHANISM
330
54(71,81,93)
300
gt
311
310
100
1
320
320
45d
45d
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316
314
315
321
321
317
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350
Z
Y
X

Fig. 13

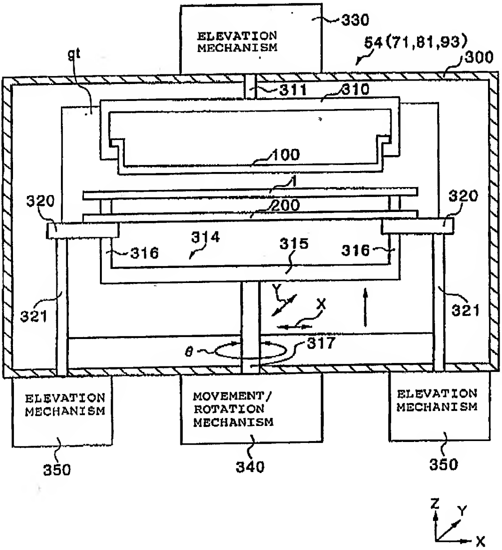

ELEVATION MECHANISM
330
54(71,81,93)
300
gt
311
310
100
1
320
200
320
314
315
316
316
321
321
Y
X
317
θ
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350
Z
Y
X

Fig. 14

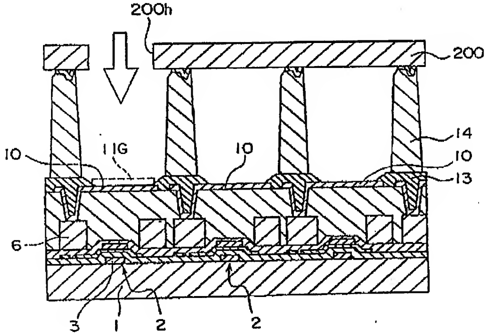
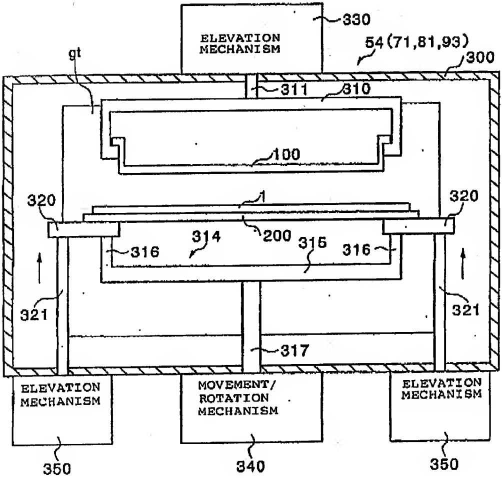


Fig. 15



ELEVATION MECHANISM
330
54(71,81,93)
300
gt
311
310
100
1
320
320
200
314
316
315
316
321
321
317
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350

Fig. 16

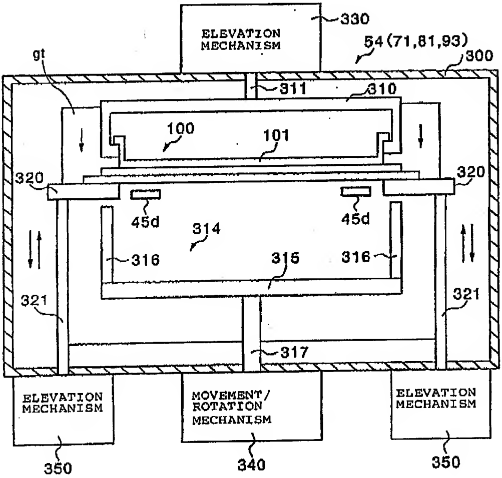

ELEVATION MECHANISM
330
54(71,81,93)
300
gt
311
310
100
101
320
320
45d
45d
314
316
315
316
321
321
317
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350

Fig. 17

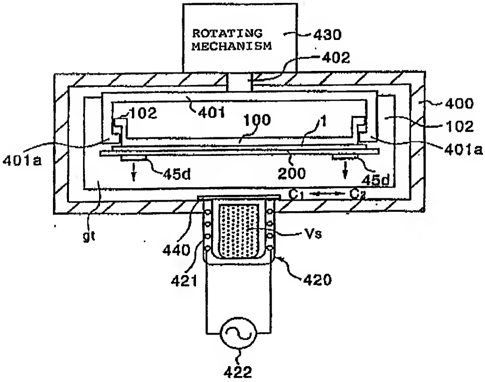

ROTATING MECHANISM
430
402
400
102
401a
401
102
100
1
401a
45d
200
45d
C1
C2
gt
440
Vs
421
420
422

Fig. 18

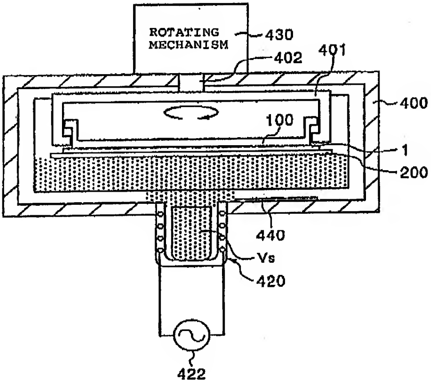


Fig. 19

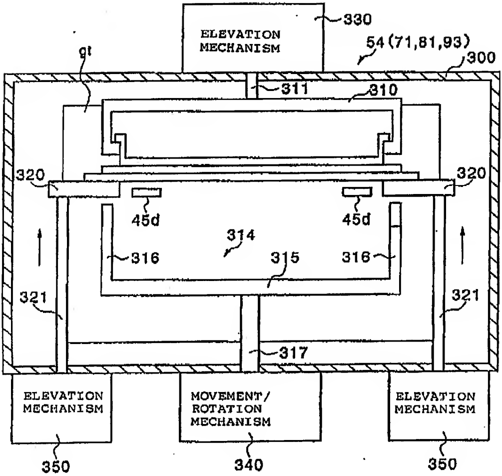

ELEVATION MECHANISM
330
54(71,81,93)
300
gt
311
310
320
320
45d
45d
314
316
315
316
321
321
317
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350

Fig. 20

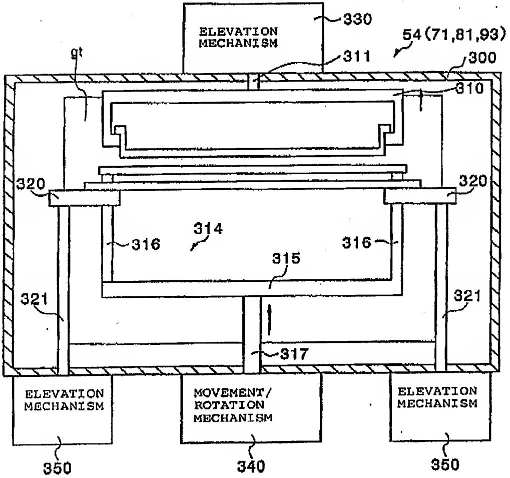

ELEVATION MECHANISM
330
54(71,81,93)
gt
311
300
310
320
320
314
316
316
315
321
321
317
ELEVATION MECHANISM
MOVEMENT/ ROTATION MECHANISM
ELEVATION MECHANISM
350
340
350

Fig. 21

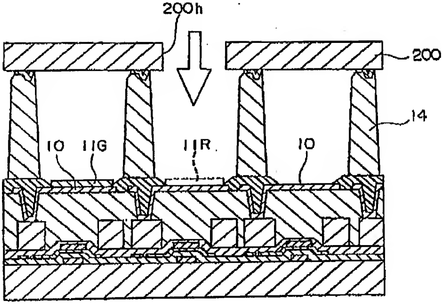
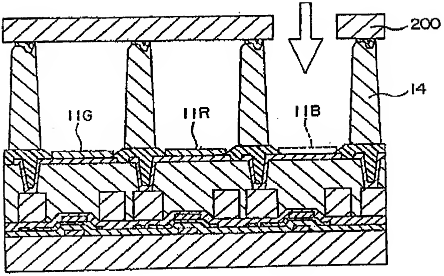


Fig. 22



[NAME OF DOCUMENT] Abstract

[ABSTRACT]

[PROBLEM] To provide an apparatus and method for forming an organic layer which is possible to shorten the cycle time of the process for forming the organic layer of an organic EL display, and which is possible to suppress waste of the organic materials used for forming the organic layer.

[MEANS FOR SOLUTION]

An apparatus has an alignment chamber 53 for aligning a mask having openings corresponding to a predetermined pattern with a substrate on which a first electrode layer is formed and detachably attaching the mask and the substrate; vacuum processing chambers 62, 63 and 64 for sequentially forming a plurality of organic material layers on the substrate attached with the mask; and a transfer robot 45 for transferring the attached mask and substrate to one of the plurality of vacuum processing chambers 62, 63 and 64 and sequentially transferring it between the plurality of the vacuum processing chambers 62, 63 and 64.

[SELECTED DRAWING] Fig. 4

S02P0681SQ00

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This is to certify that the annexed is a true copy of the following application as filed with this Office

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出願番号 Application Number:	特願2001−177682
[ST.10/C]:	[JP2001−177682]
出願人 Applicant(s):	ソニー株式会社

2002年 3月29日

特許庁長官
Commissioner,
Japan Patent Office

及川耕造

出証番号 出証特2002−3022795